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Economic Model for Investing Small versus Large Ag Equipment

Jonathan Alas
Iowa State University, jalas96@iastate.edu

Chris Davis
Iowa State University, chrisd@iastate.edu

Grant Pieper
Iowa State University, gpieper@iastate.edu

Shweta Chopra
Iowa State University, schopra@iastate.edu

Jacek A. Koziel
Iowa State University, koziel@iastate.edu

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Problem Statement

- This project will allow the client to give economic advice to its customers while making equipment purchase decisions.
- The client has customers who invest in equipment who want to maximize their efficiency and return on investment.
- This problem is not one that many operators consider, but it is something that could benefit many producers if they consider our deliverable. Solving this problem could save producers money and increase equipment field capacity allowing operators to get more done in less time. This solution can create a business opportunity for dealerships to work with their customers to find the right size equipment for them to maximize productivity and reduce costs.
- Our solution aims to be specific to clients with row crop operations. In the future, our program could be expanded into the construction market for clients looking to purchase new equipment.

Disciplines

Bioresource and Agricultural Engineering | Industrial Technology

Department of Agricultural and Biosystems Engineering (ABE)

TSM 416 Technology Capstone Project

Economic Model for Investing Small versus Large Ag Equipment

Jonathan Alas, Chris Davis, Grant Pieper, Shweta Chopra [*] and Jacek A. Koziel [*]

[*] Dept. of Agricultural and Biosystems Engineering, ISU, 4344 Elings Hall, Ames, IA 50011, schopra@iastate.edu, 515-294-4898

[*]Dept. of Agricultural and Biosystems Engineering, ISU, 4350 Elings Hall, Ames, IA 50011, koziel@iastate.edu, 515-294-4206

*course instructors and corresponding authors.

Client: Cedar Valley Innovations, 116 W Schrock Rd, Waterloo, IA 50701

Contact(s): Bob Recker, President/CEO, Cedarvalleyinnovation@gmail.com, phone: (319) 296-2200

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Business Case Statement

A. The current issue is that producer has to go through much general information when looking into purchasing new equipment. This program will allow producers to see how specific equipment will mesh with their operation. This will allow them to find a solution to increase their field efficiency and reduce their equipment costs.

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B. The problem is not very extensive. However the solution for our problem can make a significant difference for producers looking to maximize their efficiency and return on investment with equipment.
C. These problems are financial problems that occur in the overall costs of running a farming operation. This solution will help reduce costs and ultimately increase profit.
D. This problem is worth addressing because it leads to more money going back to the producer. This is a result of lower costs as well as higher efficiency.
E. The individuals who care about this solution are producers and equipment sales personnel. Producers can use this to reduce costs and improve field capacity.

1 GOAL STATEMENT

Our team will develop excel spreadsheets for producers to input values such as; equipment size and field size, calculate output values such as; efficiency and profit. Our analysis will be based on two main aspects of agriculture equipment. The cost of ownership (the investment) and the field efficiency (the return on investment). The equipment cost of ownership will be calculated based on an annual cost of ownership for the operation. Below are our assumptions for the cost of ownership. The output unit for the cost of ownership calculations will be a dollar value. The equipment field efficiency will be calculated based on equipment size and field size. The initial output units for field efficiency will be a percentage, but will later be converted to a dollar value. Both analysis points will be in terms of dollars; therefore, the investment can be compared to the return on investment to find which option produces the highest total profit for their specific operation.

- **Main Objective(s) and Specific Objectives**
    - The purpose of this report is to propose the scope of our Agriculture Equipment Sizing project. Our project is being completed as a Capstone project and will be completed with Cedar Valley Innovation. More specifically, our project will analyze different sizes of agriculture equipment against various sizes of corn and soybean farming operations.

Specific objectives include:

Assumptions:

1. Labor costs will be constant at $10 an hour.
2. Price per bushel will be constant.
3. Bushels per acre will be constant.
4. Equipment cost will be calculated based on an 8 year life span.
5. Salvage value of 20 percent will be given to each piece of equipment.
6. Interest rates will be constant.
7. Work days will be 10 hours.
8. Diesel will be $3.10 per gallon.

- **Rationale**

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Our client will be better equipped to deal with customers evaluating different equipment sizes for their operation.

- Analyzing which piece of equipment will be ideal for a particular customers field on way the customer can save money is by planting or harvesting the same number of acres in less time.
- Another way the customer can save money by analyzing which piece of equipment will be best is by not oversizing the equipment. Based on the field size and shape the customer may be able to get the same amount of work done in the same period with a smaller piece of equipment.

- **Project Scope**

- At first, we did not have a clear scope or a proposal to work with. Eventually, we met with our client and formed an official scope. With the material we learned in previous courses we were able to provide our client with a program to satisfy his needs and meet his criteria and constraints.
- We used the Iowa State Extension document *Estimating Farm Machinery Costs* to find average values of crops, average prices of equipment, probability of work factors and more.
- The data we included in our project are all parts of our client's business. We did not add anything out of the ordinary that our client would not use or suggest to his clients while providing solutions.

2 PROJECT PLAN/OUTLINE

A. Methods/Approach

- Reference Material(s)
  - Our main resource for the department is Dr. Stuart Birrell in the ABE department here at Iowa State. He is aware of our project and has offered his advice and guidance.
  - Other sources of information include data from the Iowa State Extension site. Our client is aware of our use of this information and asked that we use this for our program.

- **Data collection**:
  - Fortunately, our data was accessible via ISU resources regarding the average prices of crops for the current and past years, gas prices, work probability factors, and our tool costs were provided by our project host Bob Recker. We gathered equipment prices online by researching current equipment for sale. By having all these resources available to us, we then contacted Dr. Birrell in the ABE department and using what we learned in previous classes along with his assistance created an excel sheet to plug all these variables in.

- **Skills**:

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- In order to solve our client's problem, as a group we all needed to understand what is important to our client's customers. By understanding their wants and needs, we can successfully execute the excel sheet solution we proposed to solve any issues that a future customer of our client may have.
- Almost every class taken within our major plays a small contribution to our success in developing a tool for our client. More specifically, TSM 330 has been very helpful in putting together our deliverable. The major takeaways from this class are the equations we used to complete our equipment analysis.

- **Solutions**:
  - In the beginning, our project proposal was not clear. Lack of communication with the Ohio state group caused us to go into our project, and due to our client's schedule with harvesting season, communication was very limited. However, we put together a scope that we thought would accomplish the goals he was shooting for. After presenting our developed scope with the client, we made some small changes and had an official scope to build off of.
  - Our solution was evaluated by our client via email and was given feedback during his visits to Iowa State.
  - The metric we used to evaluate our preliminary solution was a S.W.O.T analysis. We had to understand our client's strengths and weaknesses, and understand his customers so that we can provide our client with the best possible tool to allow his customers to maximize field capacity and minimize costs.
  - We developed our metric based on customer needs and our overall goal of analyzing equipment. Yes, our client's input was critical. Without him, we would not understand what his customers are looking for when purchasing new equipment and kind of operations they are running.
  - When we discussed with our project with our client, he was pleased with our efforts. He believed this tool would save him time because the excel sheet allows him to change variables which then would display different output values. This allows his customers to see how to program works and to see different costs and field capacities associated with equipment sizes.
  - Our project proposal meets all criteria and constraints provided by our client. Our project was downsized some to allow us to go into more detail with the operations we analyzed, which are: corn harvest, corn planting, soybean harvest, and soybean planting.
  - Our communication with our client was not very consistent. At first, we did not have much communication with our client because he was finishing up harvest season. As soon as the harvest was over we were able to meet with him and have maintained fairly consistent communication with him via email. We have met with him in person twice and have exchanged regular emails at project checkpoints.
  - As a team, we all set aside time during the week to meet with our instructors so that they are aware of our progress and can make suggestions to our work, but

if we felt we needed more time we set aside time on the weekends to work on anything that needed to be done.

- Our first major milestone was finalizing the scope of our project with our client. This allowed us to get the project going, which led us into our second milestone. Next, we gathered all the data we needed to complete the project. For the most part this was equations that we used to complete our analysis. After we gathered our data, the next milestone was to put together a rough draft of our solution and present it to our client. After some changes were made here and there we were able to put together a final product and present it to our client.

  Our project scope did not ever change much, we had the opportunity to come up with our own solution based on our client's constraints and criteria. The original plan our client had for us was to work with the Ohio State team to find one solution, because of communication issues, as well as different ideas our client decided it was best for us to come up with our own solution specific to Iowa. This allowed us to run with our idea, and make it to our own specifications.

3 RESULTS

Results/Deliverables

- Our deliverable is an excel spreadsheet that compares the cost of operation and field efficiency for different sized equipment. We also analyze this against different field sizes across a few different operations.

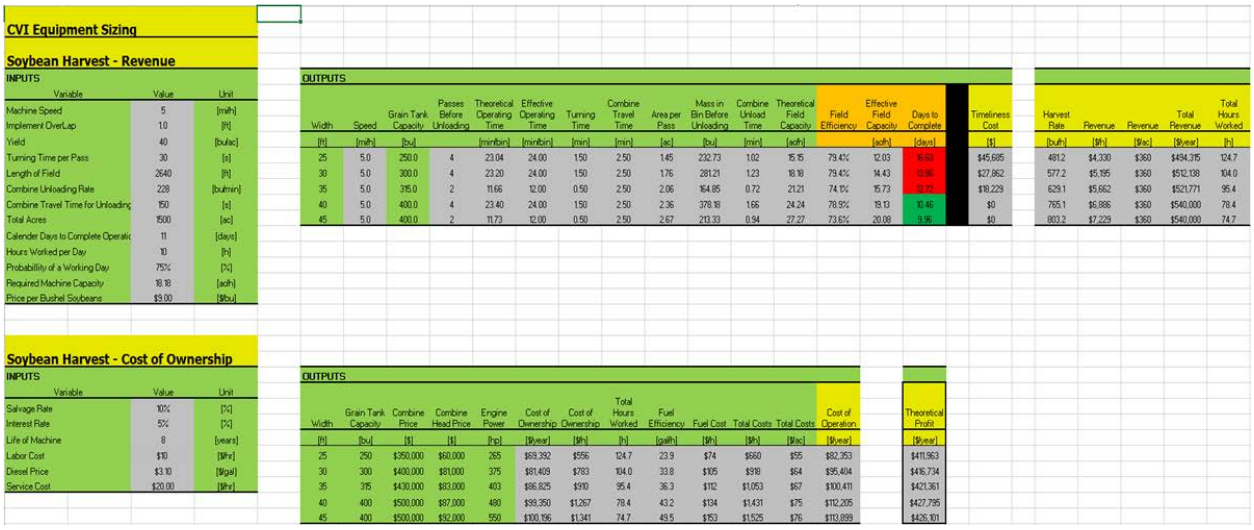
4 BROADER OPPORTUNITY STATEMENT

A. As a team, we believe our project provides everything our client needs, and it is relatively straightforward to use. It allows him to change variables with ease and allows his customers to see the changes and compare equipment options by changing just a few variables based on their operation.
B. To answer this question. This tool provides a visual for a customer to see his or her options and make an educated decision based on variables he cannot and can control. Moreover, visually see these changes on the spreadsheet.
C. At this time, our program is specifically fit for the agriculture equipment industry. I would be difficult to modify this specific program for other industries, but creating a similar program could broaden opportunities for different industries.
D. -Agriculture
   -Construction
E. We have not been able to find any alternatives to our program. It is possible that there are some out there, but in our searches, we could not find any. The closest alternatives we could find are generalized guides for equipment purchases and use. However, these guides can be very broad

and are not customized to a producers operation. Our main goal is to provide a specific solution that is custom for clients.

F. This program will save our client time when working with his clients. We believe that over time our client can use this program to help his clients make better decisions. The long term goal for this is for producers utilizing this program to find short and long term increases in their efficiency and return on investment leading to increased income.

5 GRAPHICAL ABSTRACT



CVI Equipment Sizing

Soybean Harvest - Revenue

INPUTS

Variable	Value	Unit
Machine Speed	5	[mi/h]
Implement OverLap	1.0	[ft]
Yield	40	[bu/ac]
Turning Time per Pass	30	[s]
Length of Field	2640	[ft]
Combine Unloading Rate	228	[bu/min]
Combine Travel Time for Unloading	150	[s]
Total Acres	1500	[ac]
Calender Days to Complete Operatic	11	[days]
Hours Worked per Day	10	[h]
Probability of a Working Day	75%	[%]
Required Machine Capacity	18.18	[ac/h]
Price per Bushel Soybeans	$9.00	[$/bu]

OUTPUTS

Width	Speed	Grain Tank Capacity	Passes Before Unloading	Theoretical Operating Time	Effective Operating Time	Turning Time	Combine Travel Time	Area per Pass	Mass in Bin Before Unloading	Combine Unload Time	Theoretical Field Capacity	Field Efficiency	Effective Field Capacity	Days to Complete	Timeliness Cost
[ft]	[mi/h]	[bu]		[min/bin]	[min/bin]	[min]	[min]	[ac]	[bu]	[min]	[ac/h]		[ac/h]	[days]	[$]
25	5.0	250.0	4	23.04	24.00	1.50	2.50	1.45	232.73	1.02	15.15	79.4%	12.03	16.63	$45,685
30	5.0	300.0	4	23.20	24.00	1.50	2.50	1.76	281.21	1.23	18.18	79.4%	14.43	13.86	$27,862
35	5.0	315.0	2	11.66	12.00	0.50	2.50	2.06	164.85	0.72	21.21	74.1%	15.73	12.71	$18,229
40	5.0	400.0	4	23.40	24.00	1.50	2.50	2.36	378.18	1.66	24.24	78.9%	19.13	10.46	$0
45	5.0	400.0	2	11.73	12.00	0.50	2.50	2.67	213.33	0.94	27.27	73.6%	20.08	9.96	$0

Harvest Rate	Revenue	Revenue	Total Revenue	Total Hours Worked
[bu/h]	[$/h]	[$/ac]	[$/year]	[h]
481.2	$4,330	$360	$494,315	124.7
577.2	$5,195	$360	$512,138	104.0
629.1	$5,662	$360	$521,771	95.4
765.1	$6,886	$360	$540,000	78.4
803.2	$7,229	$360	$540,000	74.7

Soybean Harvest - Cost of Ownership

INPUTS

Variable	Value	Unit
Salvage Rate	10%	[%]
Interest Rate	5%	[%]
Life of Machine	8	[years]
Labor Cost	$10	[$/hr]
Diesel Price	$3.10	[$/gal]
Service Cost	$20.00	[$/hr]

OUTPUTS

Width	Grain Tank Capacity	Combine Price	Combine Head Price	Engine Power	Cost of Ownership	Cost of Ownership	Total Hours Worked	Fuel Efficiency	Fuel Cost	Total Costs	Total Costs	Cost of Operation
[ft]	[bu]	[$]	[$]	[hp]	[$/year]	[$/h]	[h]	[gal/h]	[$/h]	[$/h]	[$/ac]	[$/year]
25	250	$350,000	$60,000	265	$69,392	$556	124.7	23.9	$74	$660	$55	$82,353
30	300	$400,000	$81,000	375	$81,409	$783	104.0	33.8	$105	$918	$64	$95,404
35	315	$430,000	$83,000	403	$86,825	$910	95.4	36.3	$112	$1,053	$67	$100,411
40	400	$500,000	$87,000	480	$99,350	$1,267	78.4	43.2	$134	$1,431	$75	$112,205
45	400	$500,000	$92,000	550	$100,196	$1,341	74.7	49.5	$153	$1,525	$76	$113,899

Theoretical Profit
[$/year]
$411,963
$416,734
$421,361
$427,795
$426,101

6 REFERENCES

- Dr. Stuart Birrell (personal communication)

7 APPENDIXES

1200 Acres Soybean		Quick	Conservative	Profitable
Equipment Investment	Harvest	$592,000	$410,000	$513,000
	Planting	$650,000	$400,000	$550,000
	Total	$1,242,000	$810,000	$1,063,000
Cost per Acre	Harvest	$92.27	$66.57	$81.02
	Planting	$95.83	$64.12	$83.21
Days Completed	Harvest	7.7	13.45	9.74
	Planting	5.6	14.24	8.28
	Harvest Theor. Profit	$375,273	$378,391	$388,774
	Planting Timeliness cost	$0	$25,178	$0
	Planting Equipment Cost	$116,011	$76,939	$99,847
		$259,262	$276,274	$288,927
1200 Acres				